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Title: Effectiveness of Occupational Safety and Health Training for Migrant Farmworkers: A Scoping Review.

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Abstract: Objective: Migrant farmworkers report higher rates of work-related illnesses, injuries and fatalities compared to local workers. Language and cultural barriers represent a relevant source of risk which can be reduced by means of targeted training interventions. This review aims at identifying and synthesizing the results of currently available literature about the effectiveness - in terms of improvement in at least one of the following variables: safety knowledge, behaviors, attitudes & beliefs, and health outcomes - of occupational health and safety training programs and interventions addressing migrant workers in the agricultural sector.

Methods: Scoping review.

Results: Twenty-nine publications met the inclusion criteria. Of these, nine cross-section studies discussed the effectiveness of training activities in terms of whether having participated in any program, had or did not have a significant effect on the dependent variables, when training was considered together with other sociodemographic factors. In the majority of these studies, training appeared to have low or no effect on the dependent variables considered. Other twenty mainly within-subjects experimental studies addressed the effectiveness of specific training methods, reporting significant improvements especially for interventions based on a participatory approach.

Conclusion: Training could greatly contribute to an effective attainment of occupational safety and health information, but the present review shows that more evidence is needed to guide the future development of effective training activities.



Torino, Italy, October 20, 2017  
To the Editors-in-Chief of *Public Health*

Dear Editors,

Please find attached the manuscript “*Effectiveness of Occupational Safety and Health Training for Migrant Farmworkers: A Scoping Review.*” I am submitting to *Public Health*, also on behalf of the co-authors.

Migrant workers report higher rates of work-related illnesses, injuries and fatalities compared to local workers. This is particularly true for agricultural workers, since agriculture is among the most hazardous productive industries and many migrants are employed in this sector. Training is an important factor in protecting and promoting farmworkers’ occupational safety and health, but it may be ineffective for migrants, because of many language and cultural barriers. This scoping review aims at identifying and synthesizing the results of currently available literature about the effectiveness - in terms of improvement in safety knowledge, behaviors, attitudes & beliefs, and health outcomes - of occupational health and safety training programs and interventions addressing migrant workers in the agricultural sector. Twenty-nine publications met the inclusion criteria. Of these, nine cross-section studies discussed the effectiveness of training activities in terms of whether having participating in any program, had or did not have a significant effect on the dependent variables, when training was considered together with other sociodemographic factors. In the majority of these studies, training appeared to have low or no effect on the dependent variables considered. Other twenty mainly within-subjects experimental studies addressed the effectiveness of specific training methods, reporting significant improvements especially for interventions based on a participatory approach. The present review shows that more evidence is needed to guide the future development of effective training activities.

We believe that the paper is closely related to the topics *Public Health* deals with. Migrants are particularly employed in agriculture, and promoting these workers’ health and safety is a relevant issue for public health researchers and practitioners. To improve training effectiveness in preventing illnesses and injuries, more information is needed about the best and worst practices in the field.

The paper is the original product of our research, and it has not been submitted to any other journal. Please, do not hesitate to contact me at [f.caffaro@ima.to.cnr.it](mailto:f.caffaro@ima.to.cnr.it) if you, or the reviewers, have any questions.

Thank you for considering this manuscript.

Sincerely,

Federica Caffaro, PhD

Running head: Occupational Safety and Health training for migrant workers in agriculture

# **Effectiveness of Occupational Safety and Health Training and Intervention Programs for Migrant Farmworkers: A Scoping Review.**

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## Abstract

Objective: Migrant farmworkers report higher rates of work-related illnesses, injuries and fatalities compared to local workers. Language and cultural barriers represent a relevant source of risk which can be reduced by means of targeted training interventions. This review aims at identifying and synthesizing the results of currently available literature about the effectiveness - in terms of improvement in at least one of the following variables: safety knowledge, behaviors, attitudes & beliefs, and health outcomes - of occupational health and safety training programs and interventions addressing migrant workers in the agricultural sector.

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## Introduction

International migrants accounts for an increasing share of agricultural labour workforce: in 2013 16.7 million migrants were engaged in agriculture worldwide, and the 74.1% of these concentrated in high-income countries<sup>1</sup>. Agriculture is one of the most hazardous industries<sup>2-4</sup>, and migrant workers are exposed to higher safety risks than local workers<sup>5</sup>, since they often work longer hours, and in poor safety conditions<sup>6,7</sup>. Indeed, they experience higher rates of work-related illnesses, injuries and fatalities compared to natives<sup>5</sup>.

One of the major risk factor enhancing migrant farmworkers' vulnerability lies in language and cultural barriers<sup>8-11</sup>. In most cases, limited knowledge of local language and low levels of literacy make it more difficult for migrant workers to understand Occupational Safety and Health (OSH) rules and may interfere with the report of health concerns and access to health care<sup>12</sup>.

Training is widely acknowledged as a key factor in promoting OSH among both local and migrant workers in many different sectors<sup>13-18</sup>. As regards agriculture, different studies<sup>19,20</sup>, and an international convention<sup>21</sup>, stress the importance of developing targeted training strategies to provide migrant farmworkers with effective preventive and protective measures. However, few empirical studies have been conducted on this peculiar workforce<sup>11,22</sup> and very little evidence is available about the effectiveness of training programs addressing migrant farmworkers.

Considering the rising share of migrants among agricultural workforce in most of the developed countries<sup>23</sup> and given the high rates of injuries and illnesses affecting these populations<sup>20,24-26</sup>, it would be important to acquire a global view over the current status of training intervention programs and their relative effectiveness. Mapping available literature on this particular topic would provide the opportunity to identify key implications for targeted future research, practices and policies.

Based on these considerations, this scoping review aims at identifying and synthesizing the results currently available in the literature about the effectiveness of OSH training programs for migrant workers in the agricultural sector.

## Methods

The literature search for the scoping review was carried out in September 2017. Relevant articles were searched from four databases: PUBMED, PsycINFO, SCOPUS and WEB OF SCIENCE. The search terms ‘training’ AND ‘migrant’ AND ‘method’ OR ‘program’ OR ‘intervention’ were used to identify relevant articles. Publications from peer-reviewed journals and empirical studies, as well as conceptual papers have been included. The review included articles reporting investigations conducted in any geographical area and published in English.

After removing the duplicates, the remaining articles were screened in order of titles, abstracts and then full text. To be included in the literature review, the publications had to meet the following criteria: (i) the reported study had to focus on a working population; (ii) the occupational sector addressed in the study had to be agriculture; (iii) the topics of the training should deal with OSH issues; (iv) results had to concern the effectiveness of the training programs, including at least one of the following dependent variables (based on the categorization used by Burke et al.<sup>16</sup> and Robson et al.<sup>15</sup>): safety knowledge (SK), safety attitudes & beliefs (SAB), safety behaviors (SB), or safety and health outcomes (HO). Figure 1 illustrates the selection process of the review. The screening was performed independently by two authors and any disagreement was resolved through discussion until consensus was achieved. Once the papers eligible for inclusion were selected, the objectives, design, sample and setting, interventions, and findings of each study were recorded. No quality assessment tool for publications and researches considered by this study has been used, since a scoping review does not aim at critical appraisal<sup>27</sup>.

---Figure 1 about here---

## Results

The exploration on databases identified 2251 articles containing the search terms. After the removal of duplicates (n=506), articles were screened on the basis of inclusion and exclusion criteria applied to titles, abstracts and full-text. Finally, 29 publications were retained to be included in the final

review analysis (Figure 1).

## ***Contexts and Populations of Training***

The studies and the interventions described in the selected papers were mainly conducted in the United States (n= 28), apart from one study performed in Australia-Indonesia<sup>28</sup>. As regards the migrant population targeted by the studies, 24 papers include samples of Latino/Hispanic farmworkers, 1 refers to Indonesians and Australians, and 4 refer to a population of mixed ethnic origin (e.g. African American, Hispanic-white, Non Hispanic-white).

## ***Summary of findings according to the evaluation of training effectiveness***

All selected studies reported a quantitative and/or qualitative assessment<sup>27</sup> of training effectiveness in terms of changes in at least one of the dependent variables, or in some combination of the four. In particular, SB as well as SK were addressed in 21 articles. SAB and HO were considered in 11 and 3 articles, respectively. However, two different ways of investigating training effectiveness have been detected: a) 9 cross-section studies<sup>8,12,29-35</sup> investigated the effects of participation in any training program together with other factors, mainly sociodemographic characteristics and work history (Table 1); b) 20 mainly within-subjects experimental studies<sup>10,28,36-53</sup>, addressed the effectiveness of specific OSH training methods (Table 2). Results will be presented separately for the two different approaches to training effectiveness.

---Table 1 about here---

---Table 2 about here---

## ***Effectiveness of having participated in any training program***

The majority of the 9 studies concerning the participation in training programs (Table 1) report that training and education programs have low or no effect on the dependent variables considered<sup>12,29-35</sup>.

With respect to SK, one study<sup>12</sup> observed that a very poor knowledge of basic OSH concepts persisted also in trained groups of young migrants and advanced the use of alternative media (e.g. internet) as a future training mode specifically addressing youth. No consistent relationship between



1 training and SK was found in the study by Lam et al.<sup>33</sup> since farmworkers who had never received  
2 formal training, demonstrated to know the risks and symptoms of work-related illness. In 2  
3 studies<sup>31,34</sup>, self-reported knowledge on OSH issues resulted very low and the workers themselves  
4 revealed they were not well-trained in preventing occupational injuries. Interviewed workers  
5 reported a scarce efficacy of provided training also in the study by Farquhar et al.<sup>30</sup>, since the  
6 training material was in a non-native language.

7 As regards advances in SB, only one<sup>8</sup> of the reviewed studies detected a positive association  
8 between having received training and increased use of Personal Protective Equipment (PPE). On the  
9 other hand, Halfacre-Hitchcock et al.<sup>32</sup> concluded that even though the respondents appear to be  
10 knowledgeable about occupational risks, this did not appear to be related to engagement in  
11 protective behaviors. Interestingly, Walton et al.<sup>35</sup> reported the recency of training as an item that  
12 could most affect SB.

13 Most of researches<sup>8,29,33,34</sup> indicate that training did not affect SAB, and none of the reviewed  
14 studies considered HO as a dependent variable to assess the effects of having received training.

#### 15 *Effectiveness of specific training methods*

16 Most of the 20 papers concerning specific training methods (Table 2) describe the process adopted  
17 for the design of the training program, and reported a pre- post- and follow-up assessment of its  
18 effectiveness, often pointing out significant changes in many dependent variables.

19 SK improvement was observed in a substantial number of researches. One study<sup>36</sup> employing a  
20 computer-based training software indicated a highly significant increase in SK, especially among  
21 highly educated participants. The same effects on SK were reported in a research-based  
22 intervention<sup>44</sup> which tested a more comprehensive educational resource (Toolkit), combining  
23 different training methodologies including flipcharts, visual materials, hands-on learning activities  
24 and bilingual handouts.

25 As regards SB, a number of interventions envisaged the presence of a peer educator or similar  
26 figures (e.g. lay health educators, community health workers, health promoters). Five pilot

studies<sup>39,46-48,52</sup> assessed the efficacy of a model combining community-based participatory research with peer to peer education. At the end of these programs, an increased use of PPE compared to baseline or control groups was observed in all studies. Another study<sup>41</sup> observed an improvement of migrant workers' SB after they have been trained through a videotaped theatre program followed by a practical demonstration of correct movements and postures and selected stretches for injury prevention.

As regards SAB, the majority of the studies reported significant positive effects of training<sup>41,43,44,47,50,54</sup>; nevertheless, a follow-up study by Forst et al.<sup>40</sup> showed that even after experiencing the intervention (health promoter and PPE distribution) for two seasons, some barriers in the use of PPE persisted.

Often, a significant positive effect of training has been reported for different dependent variables at the same time, especially SK and SB. Two community-based interventions<sup>50,51</sup> based on discussions and demonstrations supported by field safety promoters, videos and printed materials (flipchart and brochures), resulted in SK and SB advancement. Similar results were reported in another pilot study<sup>45</sup> envisaging a peer educator combined with a comic book translated into farmworkers' native language. The same outcomes were observed in the study by Forst et al.<sup>39</sup> and by Juarez-Carrillo et al.<sup>42</sup>. Another intervention<sup>53</sup> was characterized by the use of interactive flipchart and discussion of real or simulated scenarios. Much emphasis was given to the bilingual format of the training, which effectively increased farmworkers' SK and SB. With regard to this language issue, it should be noticed that apart from two cases<sup>8,43</sup>, training and assessment materials were usually provided in multi-languages including English, and the native language of learners (mostly Spanish).

The training program described by Hamilton and Sidebottom<sup>10</sup> also allowed interaction and questions at the end of the training. After the intervention, besides a noticeable improvement in the use of safety equipment (SB), the knowledge about proper use of safety equipment and application practices persisted even after one month (SK). Moreover, two studies by Elkind et al.<sup>38</sup> and

Napolitano et al.<sup>49</sup> proposed a participatory design of a community-based OSH program, consisting in theatre scripts and educational videos. For both methods, SK increased as much as SB.

In some cases, the same study reported contrasting results as regards training effectiveness on the different dependent variables considered. Indeed, one study<sup>28</sup>, based on discussions after flipcharts and slideshow, reported an increase in SK, whereas SAB and SB did not significantly improve at follow-up evaluation. Another program<sup>37</sup> involved trained lay health educators who conducted training workshops and information sessions with workers and their families, using flipcharts and short conversations with participants. This program resulted in an increase in terms SK, but this did not lead to changes either in SAB or SB. Likewise, the intervention by Kilanowski et al.<sup>43</sup>, which combined classroom learning and instructional safety videos created by students, resulted in a slight increase of SK, while risk-taking behaviors (SB) were unchanged and injury experience even slightly increase (HO). However, the results differentiated after splitting data by gender and age.

## Discussion

The reviewed articles highlighted two main different approaches to address training effectiveness in terms of SK, SB, SAB, HO improvement, and some contrasting results emerged. A first group of articles investigated the effects of training when the participation in training programs was considered together with other variables. These studies mainly found no statistically significant differences in terms of either SK, or SB, or SAB between trained and untrained migrant farmworkers. The authors of many of these studies interpret this scarce effect of training as due to the lack of tailored programs addressing migrants' language and cultural peculiarities<sup>12,29,31-34</sup>, but since no information is given about the type of received training, no definite conclusions can be drawn. Furthermore, some authors pointed out that participants may already have some naïve SK<sup>54</sup> which should be detected and used as a basis to design effective educational programs targeting farmworkers' SB and SAB. This consideration encourages the adoption of an ergonomic user-centered approach<sup>55</sup>, which states the importance of an active involvement of the users, to point out their needs and capabilities and design tools and services accordingly. The usefulness of this

1 approach is mirrored by the evidence emerging from the second group of studies considered in this  
2 review, which demonstrated positive effects on the considered dependent variables for the majority  
3 of the cases. Indeed, these studies typically reported research-based interventions, pilot studies or  
4 field-experiment initiatives which involve learners also in the development of the training activities  
5 and materials. In some cases<sup>36,38,43,49-51</sup> migrant farmworkers' needs were identified by means of a  
6 participatory approach before developing the training program, and the program then focused on the  
7 main issues and barriers which may hinder training effectiveness. As a demonstration of this, since  
8 the language was cited by some studies<sup>8,30</sup> as one of the major barriers for training effectiveness, all  
9 reviewed training interventions involved interpreters and multi-language materials, in accordance  
10 with international conventions<sup>56,57</sup> and scientific literature suggestions<sup>5,11,58,59</sup>.

11 The review showed that the effectiveness of specific training methods differ in relation to the  
12 dependent variable considered and to the level of engagement of the proposed intervention. The  
13 most investigated variables were SK and SB, and positive effects of training were often reported for  
14 both these variables. However, in some cases<sup>28,37,43</sup> the improvement in SK was not associated to a  
15 corresponding enhancement of SB, consistent with previous studies performed within the field of  
16 behavioral sciences<sup>60</sup>.

17 With regard to SB and SAB, the review found strong evidence for effectiveness of those training  
18 methods classified by Burke<sup>16</sup> as high-engaging, such as the peer education. This finding is in  
19 accordance with previous reviews on OSH training<sup>11,61</sup> concluding that the higher the level of  
20 engagement in training activities is, the bigger the effects of training are<sup>11,28,29</sup>.

21 There is ample evidence in the training literature that active approaches to learning are superior to  
22 less active approaches<sup>62</sup>. However, the review showed that when written materials (eg. slideshows,  
23 pamphlets, comic book, handouts) -belonging to the so called low-engaging methods<sup>16</sup>- are used as  
24 a reinforcement for high-engaging methods, positive responses are observed as regards SK.

25 Moreover, medium-engaging interventions<sup>16</sup>, characterized by elements of interactivity and  
26 feedback such as lectures with discussion afterwards, interactive computer instruction and

flipcharts, gave positive results as well, both in terms of SK and SB.

Finally, interventions involving farmworkers' families and communities in training programs reported the higher effectiveness, particularly on SB<sup>37-39,45,47-52</sup>, but also on SK and SAB. As reported by Suratman<sup>28</sup> this result may be due to the role of 'cues to action'<sup>28</sup> played by people. Indeed, according to the Health Belief Model theory<sup>63</sup>, others provide the individual with a motivational incentive, encouraging or triggering a behavioral change by using appropriate reminder systems, promoting awareness, or providing information.

It should be noticed that only few studies presenting specific training methods<sup>41,47,52,53</sup> reported some comparisons between experimental (i.e. trained with the new materials) and control groups; in addition, only one study<sup>43</sup> checked for differences in training effectiveness when also sociodemographic variables (i.e. age and gender) were considered.

Some limitations and unexplored areas of intervention were detected in the reviewed articles. First, most papers reported interventions conducted in the United States, and addressed communities of migrant farmworkers with a mainly Latino/Hispanic origin. This can be easily understood considering that Mexicans are the most represented country of birth among US immigrants (approximately 27% of total immigrant population in 2015<sup>64</sup>). However, the literature appears to overlook the European context, which nonetheless is characterized by a high heterogeneity of nationalities, cultures, and languages, and important migrations fluxes. Indeed, in the European Union, in 2016, there were 16.0 million persons with EU Member State citizenship living in another EU Member State, while non-EU citizens residing in a Member State were 20.7 million, representing 4.1 % of the EU-28 population<sup>65</sup>. Furthermore European countries have been the destination of almost three-quarter of the 1,6 million asylum requests attained in 2015-2016 OECD (Organization for Economic Cooperation) countries<sup>66</sup>. According to these figures, more attention should be paid to OSH interventions for migrants workers in the European countries.

Secondly, the majority of reviewed training programs targeted SB while migrant farmworkers' SAB are less frequently considered. Farmers' perspectives on health, safety and work-related risks are

known to be important sources of risk<sup>67</sup>, and usually they are difficult to modify<sup>40</sup>: therefore, more evidence on the effectiveness of training interventions for these variables is needed. Finally, some limitations are related to the methods used in the reviewed studies. Indeed, the self-report evaluation typically adopted in these studies, may be subjected to bias toward socially desirable answers<sup>68–70</sup>. Some more objective indicators of the effectiveness of training may be obtained by considering health outcomes, which nonetheless are underinvestigated in the reviewed studies.

### *Limitations of the review*

Some limitations of the present review have to be mentioned. First, the search was limited to English language publications. Second, unpublished studies, with limited distribution (the so-called “grey” literature<sup>71</sup>) were not included in the review because not indexed in bibliographic databases. Finally, even though it was performed by two authors independently, the screening of the studies was characterized by a certain degree of subjectivity. This was particularly outstanding when deciding whether to consider as ‘training-focused’ some studies in which training was only one of a wider set of variables which may affect farmers’ SK, SB, SAB or HO.

### **Conclusion**

The results of the present review raised some considerations as regards the effectiveness of training in improving SK, SB, SAB and HO in migrant farmworkers:

- 1) when the mere participation in training programs is considered, without having any control over the methods and materials used during the interventions, in most cases, training does not appear to have any significant effects on the dependent variables;
- 2) an improvement in SK is not always mirrored by an increased adoption of SB or by a change in SAB;
- 3) some improvements in SK, SB, SAB are reported, especially for those programs based on community participation, peer-educator and demonstrations, thus pointing out the fundamental role of a participatory approach to the training process, in which the workers are proactively engaged in the development of their own training.

Migrant farmworkers represent a vulnerable population worldwide<sup>2</sup> and a great amount of risk is related to language and cultural barriers which prevent an effective attainment of OSH information. Training could greatly contribute to overcome this issue, but more evidence is needed to guide the future development of effective training activities.

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Figure 1

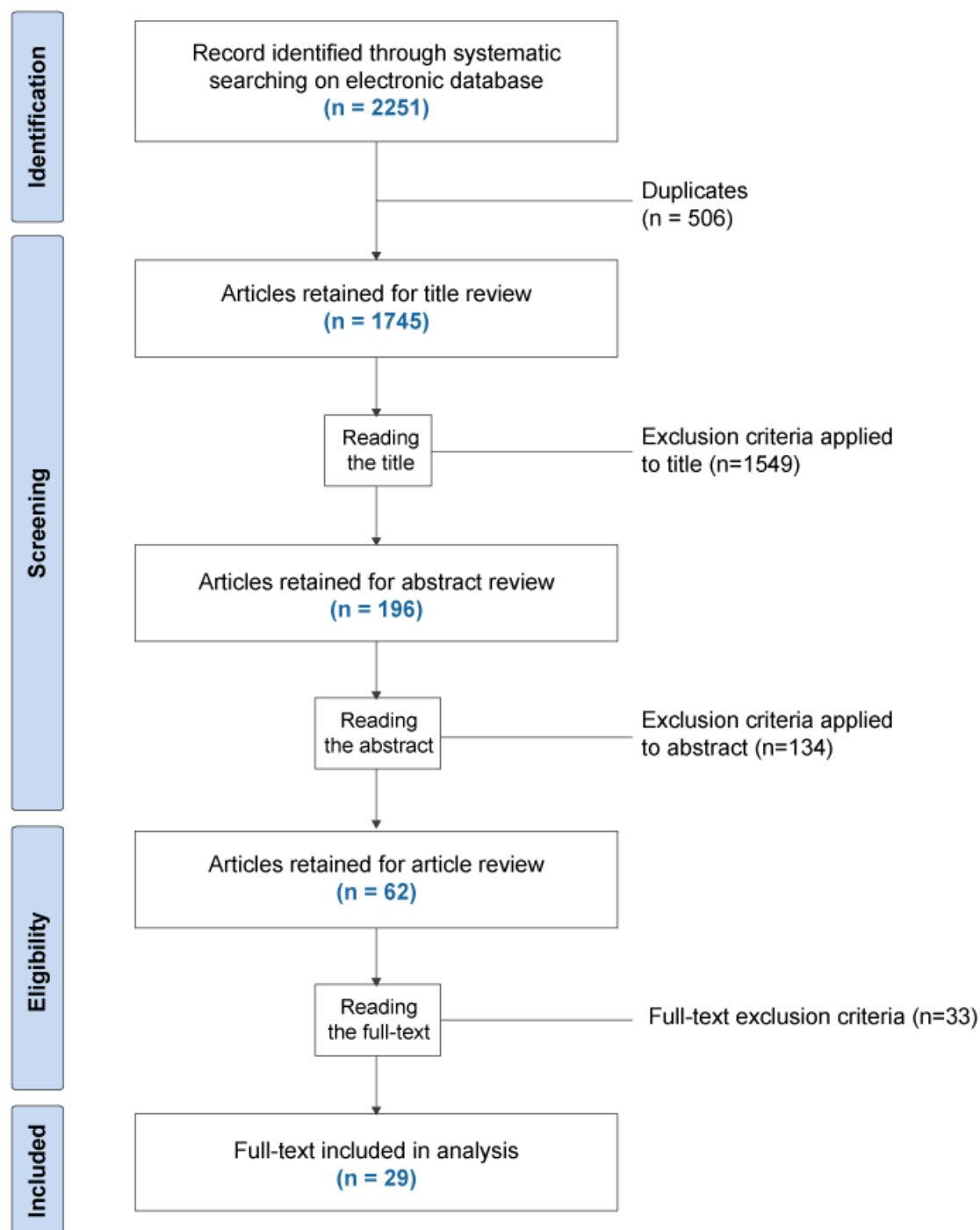


Fig. 1. Flow diagram outlining the search and study selection process.

Table 1

Table 1 – Summary of cross-section studies investigating participation in OSH training as a determinant of safety knowledge (SK), behaviors (SB), attitudes & beliefs (SAB) and health outcomes (HO).					
Reference	Study objective	Study design	Setting and participants	Dependent variable	Findings
Austin et al. (2001) <sup>29</sup>	To examine perceptions of control over pesticide exposure among farm workers in North Carolina in order to investigate how it is related to self-protective behavior	<ul style="list-style-type: none"> <li>• Survey interviews (fixed-response questionnaire in English and Spanish);</li> <li>• In-depth interviews and focus groups</li> </ul>	Sample: Hispanic migrants (n= 348) 98% from Mexico Setting: USA (North Carolina)	SB SAB	Survey interview: farmworkers perceived a lack of control over pesticide exposure in the workplace even after receiving training. In-depth-interviews identified 4 themes: i) difficulty in communicating with employer ii) difficulty in using protective equipment iii) time pressure on the job iv) lack of reliance on benefit from increased work safety
Farquhar et al. (2008) <sup>30</sup>	To assess farmworkers' understanding of the hazards associated with agricultural work in relation with the language of training materials	Baseline survey questions (107 items) in English and Spanish	Sample: indigenous (n=76) and Latino nonindigenous (n=74) farmworkers. Indigenous: from Mexico and Guatemala Setting: USA (Oregon)	SK	Respondents reported to receive inadequate training about how to protect themselves. No training was conducted in any indigenous language. 87% of indigenous workers understood Spanish well enough to understand oral information, 40% written information. Workers much preferred to receive materials and understood information when presented in their indigenous languages
Fleischer et al. (2013) <sup>31</sup>	To determine which factors could potentially reduce the prevalence of heat-related illness (HRI) symptoms among migrant farmworkers	In-person survey interviews in Spanish, English or Haitian Creole	Sample: migrant farmworkers (n = 405), 80% Hispanic Settings: USA (South Georgia)	SK SB	71% of participants reported experiencing at least one HRI symptom in previous week. These were primarily associated with working conditions and hydration techniques. A lack or inadequacy of prevention behaviors were recorded. Only 24% of the participants reported receiving some type of HRI prevention training during the year
Halfacre-Hitchcock et al. (2006) <sup>32</sup>	To assess farmworkers' healthcare access and status and perception of pesticide exposure risk	Close-ended questionnaires conducted verbally in Spanish	Sample: Latino farmworkers (n = 109) Settings: USA (South Carolina)	SK SAB	40% farmworkers reported received training on pesticides. No significant association was observed between either training and perception of exposure to pesticides or training and knowledge of risk reduction activities or training and use of PPE
Lam et al. (2013) <sup>33</sup>	To identify potential barriers to HRI prevention and treatment, including culturally-grounded beliefs	<ul style="list-style-type: none"> <li>• 3 focus groups (11-12 people each) in Spanish using semi-structured interviewing techniques;</li> <li>• Participatory Rural Appraisal (PRA) methods: participant-</li> </ul>	Sample: Latino farmworkers (n=35) 97% from Mexico Settings: USA (Central WA)	SK SB SAB	The majority of participants reported never receiving formal HRI training, most participants were aware that extreme heat can cause illness Most participants accurately described HRI symptoms and causes but reported practices were not necessarily consistent with reported knowledge.

		generated visual diagrams and maps, direct observations and journaling of local conditions, analytic games, storytelling, and seasonal calendars			
Perla et al. (2015) <sup>12</sup>	To conduct a survey among Latino-American Youth and to identify and address occupational and environmental health concerns	<ul style="list-style-type: none"> <li>• 45-items survey (in English or Spanish);</li> <li>• Bilingual RCAT (Rapid Clinical Assessment Tool) containing 20 illustrations of distinct agricultural tasks associable to occupational hazard</li> </ul>	Sample: young farmworkers (n = 140). 76,4% Hispanic, 20,7% Non-Hispanic, 2,9% N.A Settings: USA (Washington)	SK	Despite 53% of respondents reported having received OSH training or perceiving information from family, their knowledge of basic OSH concepts, appeared very poor. Internet emerged as a key mode for future OSH education and injury prevention activities
Strong et al. (2008) <sup>8</sup>	To raise awareness about pesticide exposure in agricultural communities and reduce the pesticide exposure in farmworkers households	Community-based participatory research approach. 73-items questionnaire administered by locally hired and trained bilingual staff	Sample: Hispanic and non-Hispanic white farmworkers (n = 554). 89% Hispanic and 91% lived in the Yakima Valley year-round Settings: USA (Washington)	SB SAB	65% non-Hispanic Whites and 24% Hispanic reported having been trained in the last 5 years. Receipt of training was associated with increased use of Pesticide Protective Equipment (PPE)
Verma et al. (2011) <sup>34</sup>	To describe eye protection use among migrant farmworkers and to determine the knowledge, perceptions, and risk beliefs of farmworkers about eye health and safety	Interviewer-administered questionnaire in Spanish	Sample: Latino farmworkers located in three eastern North Carolina counties (n = 300) Settings: USA (North Carolina)	SK SAB	Approximately 70% farmworkers reported that they do not use eye protection and are not well trained in preventing eye injuries. Wrong beliefs and perception of risks are the main causes of farmworkers' eye injuries
Walton et al. (2017) <sup>35</sup>	To assess the knowledge and beliefs of Latino farmworkers in North Carolina about the threat of health effects of pesticides	<ul style="list-style-type: none"> <li>• A work-day observational checklist;</li> <li>• 2 questionnaires verbally administered in Spanish</li> </ul>	Sample: Latino farmworkers (n = 72), 97% from Mexico Settings: USA (North Carolina)	SK SB SAB	97% farmworkers reported receiving pesticide training. Nearly all farmworkers agreed pesticides cause health problems, can increase the cancer risk and PPE was efficacious in minimizing exposure but during in-fields observations they result less adherent to using protective washing. Recency of pesticide training was the only variable related to observed washing scores

Table 2

**Table 2 – Summary of mainly within-subjects experimental studies in which the development of specific OSH training methods was described and their effectiveness assessed in terms of safety knowledge (SK), behaviors (SB), attitudes & beliefs (SAB) and health outcomes (HO)**

Reference	Study objective	Intervention	Study design	Setting and participants	Dependent variable	Findings
Anger et al. (2009) <sup>36</sup>	To assess farmworkers' knowledge after Worker Protection Standard (WPS) training using a computer-based system	10 infosets and questionnaire (15 quiz questions) using a computer-based training software characterized by: i) self-pacing and interactivity; ii) clear user instructions; iii) icon-based navigation; iv) pictures and/or a movie on all screens; v) spoken-language option selectable	Pre-test, post-test and re-test with the same 38 questions in a different order	Sample: Hispanics (n = 61) born in Mexico. Settings: USA (Northwest Oregon)	SK	Pre-test: high level of baseline knowledge (75% of correct answers). Post-test: training increased significantly the knowledge (up to 85% of correct answers). Re-test after 5 months: performance loss (78% of correct answers)
Bush et al. (2014) <sup>37</sup>	To determine whether the "Promotora" program contributes in increasing community capacity to protect workers' health and led to any changes in workers behavior. To identify strengths and weaknesses of the program	<ul style="list-style-type: none"> <li>• The program consisted of three parts: i) to train <i>promotoras</i> (lay health educators); ii) to develop educational tools for the <i>promotoras</i> to use; iii) to provide training workshops and information sessions;</li> <li>• Promotoras used flipchart containing worker injury stories and short guide lines to engage workers in conversations</li> </ul>	<ul style="list-style-type: none"> <li>• Focus group;</li> <li>• CAC (Community advisory committee) evaluation meeting;</li> <li>• Promotora debriefing;</li> <li>• Post test: administered by the "promotoras" reading questions aloud and explaining the cues, regarding knowledge, attitudes and motivation to make change</li> </ul>	Sample: Latino forest workers (n = 7 for focus groups and n = 263 for post-test), community members (n = 9), <i>promotoras</i> (n = 3) Settings: USA (Southern Oregon)	SK SB SAB	Capacity to address working conditions increased among both <i>promotoras</i> and workers. Increase of : community capacity to address working conditions, workers' awareness of safety and health issues, leadership and access to information. Post-test: majority of participants answered questions correctly (over 90% in some questions)
Elkind et al. (2002) <sup>38</sup>	To test the effectiveness of theater as an educational tool to provide health education	4 Spanish one-act plays (40 minutes each) scripted with participatory approach	<ul style="list-style-type: none"> <li>• Pre/post questionnaires containing 7-8 questions ;</li> <li>• Follow-up telephone interviews with open-ended questions</li> </ul>	Sample: Hispanic farmworkers and their family (n=301 for questionnaires; n=30 for interviews) Settings: USA (WA)	SK SB SAB	Questionnaire: from pre-test to post-test knowledge increased of 13,6%. Follow-up: participants demonstrated to retain some of the health and safety messages
Forst et al. (2004) <sup>39</sup>	To evaluate the Community	• 16 CHWs were recruited from farmworkers and trained (20	• 20-item questionnaire before and after the	Sample: Latino farmworkers (n =	SK SB	Block A showed the greatest improvement in knowledge on questions related to

	Health Worker (CHW), “ <i>promotor de salud</i> ” model as a tool for reducing eye injuries and illnesses in Latino migrant and seasonal farm workers	hours in English and Spanish). Trainings tools included: photographs, fotonovelas, hands-on tools to demonstrate eye injuries and hazards; • 3 intervention blocks: a) CHWs provided protective eyewear and training, b) CHWs provided eyewear but no training; c) eyewear was distributed with no CHW present and no training	intervention; • Observation at the beginning and at the end of the season on each farm	786) Settings: USA (Michigan and Northern Illinois)	HO	training content. After intervention, participants in every block were more likely to wear protective eyewear. Block A workers had a greater increase in eyewear use than Block B. Block C had the lowest increase. Surveillance of eye injuries by <i>promotores</i> was inadequate to demonstrate a reduction of injuries
Forst et. al. (2006) <sup>40</sup>	To determine the perceived benefits and barriers to use of protective eyewear during agricultural work among LFWs (Latino Farmworkers)	Recruitment of promotores de salud by a community-based farm worker organization. Safety glasses distribution and training sessions regarding use of safety glasses and eye protection	Observation once per week (from 12 to 16 weeks) on each farm, and questions on fields	Sample: Latino farmworkers (n = 55) Settings: USA (Illinois and Michigan)	SAB	LFWs reasons for use and non-use of safety eyewear were categorized in: i) perception of risks and effectiveness of eye protection; ii) eyewear provided iii) impact on visual acuity; iv) comfort; v) appearance; vi) nuisance of carrying them
Hamilton and Sidebottom (2011) <sup>10</sup>	To provide workers with more-appropriate pesticide safety training and to help members Spanish-speaking staffs to develop regular pest scouting schedules on farms	1 hour tailgate training (in Spanish) followed by Q&A session. At the end of each training each worker was provided of free safety clothes to encourage their proper use in the field and handouts in Spanish were distributed	• Pre-workshop survey; • Survey immediately after workshop day; • Follow-up interviews	Sample: Latino workers (n = 100 approx.) Settings: USA (North Carolina)	SK SB	Use of safety equipment was noticeably improved from past years; After one month workers felt more knowledgeable and conscientious about proper use of safety equipment and application practices
Holmes et al. (2008) <sup>41</sup>	To promote correct ergonomic behavior among migrant and seasonal fruit	• Warehouse workers: videotaped Spanish “fotonovela” play with English subtitles; demonstration and practice of correct lifting techniques;	Pre-test questionnaire Post-test questionnaire Lifting evaluation tool: field observation after program and 2 weeks	Sample: Latino warehouse workers (n = 178) and undergraduate latino students familiar to	SB	Warehouse workers’ correct answer regarding the prevention of back injuries: 72% before training and 85.3% after the training. Average total number of correct lifting

	warehouse workers	distribution of pamphlets; • Students: 2 experimental groups: 1) observation and practice of proper body mechanics for lifting; 2) control group, observation only	later	farmworker (n = 15) Settings: USA (Washington)		behaviors increased from before training to post-training for both warehouse workers and students experimental group
Juárez-Carrillo et al. (2017) <sup>42</sup>	To design a safety and health curriculum for dairy immigrant workers aiming to increase knowledge, encourage safe behavior and reduce worker communication inequalities	Five 1-hour lesson modules in English and Spanish including: learning objectives, background information, facilitator's guide, slide presentation and supplemental materials (flyers, comic books, posters)	<ul style="list-style-type: none"> <li>• 5 focus groups to understand context and recognize common hazards;</li> <li>• 5 brief multiple-choice questions pre- and post-training;</li> <li>• 3 open-ended questions including satisfaction evaluation</li> </ul>	Sample: Hispanic immigrant dairy workers (n = 338) Settings: USA (Wisconsin)	SK	Significant difference in mean scores between pre- and post-training tests for each lesson. Pre-training: limited knowledge especially about rights, responsibilities, animal handling, risk with machinery. Post-training: overall significant knowledge gain of 25%. Open ended questions: nearly 100% of the trainings met the learning objectives.
Kilanowski (2014) <sup>43</sup>	To test the effectiveness of a middle school student-participatory safety intervention before (T1) and after (T2) training and creation of instructional safety videos for peer education	<ul style="list-style-type: none"> <li>• Lower school students: five 30-minutes sessions. Students were given 1 week to take photos to reflect places they liked to play;</li> <li>• Middle school students: 45 minutes daily instructional sessions. Meetings were weighted more on safety knowledge at the start of the program and on video production near the conclusion</li> </ul>	Pre- and post-intervention survey	Sample: Latino farmworker student attending lower school in grades 3 to 8 (n = 80), and middle school in grade 6 to 8 (n = 37) Settings: USA	SK HO	Data by gender: tests showed statistical difference in females over males in T2 scores; males had lower safety consciousness, increased dangerous risk-taking and slightly increased injury experience. Data by grade school showed a statistical difference in middle school students over lower school students in safety knowledge. Older students showed lower safety consciousness at both T1 and T2.
LePrevost et al. (2014) <sup>44</sup>	To test increasing knowledge among farmworkers. To assess the effectiveness of a <i>Toolkit</i> to	A comprehensive educational resource ( <i>Toolkit</i> ) consisting of a training flipchart with a trainer's guide and visual materials for the audience; hands-on learning activities; and a one-page, take-home handout	Pre- (17 questions) and Post- (18 questions) intervention instrument orally administered	Sample: trainers (n = 4) farmworkers (n = 20) of Hispanic/Latino ethnicity or from Mexico or Central America	SK	The <i>Toolkit</i> is an effective, research-based pesticide safety and health intervention. Farmworkers demonstrated significant increases in knowledge of the training content from 64.4% on the pre-lesson assessment to 77.5% post-lesson.

	improve farmworkers' knowledge of Worker Protection Standard (WPS)	for learners (in English and Spanish)		Settings: USA (North Carolina)		
Liebman et al. (2007) <sup>45</sup>	To promote health messages based on the tradition of "educación popular" using " <i>promotoras de salud</i> "	<ul style="list-style-type: none"> <li>• Farmworkers trained by <i>promotoras</i> during home visits and small group workshops. Within four weeks, the <i>promotoras</i> returned to the home for a second visit;</li> <li>• Each family received a 16-page comic book (in Spanish) to educate parents about pesticide risks</li> </ul>	<ul style="list-style-type: none"> <li>• A simple one-page pre-assessment prior the educational intervention;</li> <li>• Post-assessment instrument;</li> <li>• Monitoring visits with <i>promotoras</i></li> </ul>	Sample: Latino/Hispanic farmworkers and their families (n = 273) Settings: USA (New Mexico)	SK SB	The project resulted in a significant increase in knowledge about the routes of exposure, the vulnerability of children, the signs and symptoms of pesticide poisonings and the ways to minimize pesticide exposures. Also behaviors aimed at minimizing pesticide exposure through accidental poisonings in the home improved
Luque et al. (2007) <sup>46</sup>	Implementation evaluation of an eye safety curriculum using the Camp Health Aide (CHA) model and a peer-educator to increase positive perceptions toward the use of safety eyewear and reduce eye injuries	Trained CHAs trained workers employing flipcharts and <i>fotonovelas</i> , and they were supported by educational training posters	<ul style="list-style-type: none"> <li>• Pre-training: brief survey. Focus groups at home and in the yards;</li> <li>• Evaluation: i) 3 focus groups sessions with CHAs; ii) 2 focus groups with farmworkers; iii) questionnaire (n = 74 1<sup>st</sup> year of project and n = 76 2<sup>nd</sup> year of project); iv) 18 days of field observations of farmworkers (n = 277)</li> </ul>	Sample: Mexican migrant citrus farmworkers (n=55 for pre-training; evaluation: n=427) Settings: USA (Southwest Florida)	SB SAB	The CHAs helped their fellow workers with eye washings and other injury-related activities. In 2005, a higher percentage of CHAs helped with eye drops (74%) than in 2004 (64%). Changes in workers' perceptions about the effect of wearing safety glasses on harvesting productivity, speed of harvesting, harvesting without worry, and experience with eye irritation and eye fatigue.
Monaghan et al. (2011) <sup>47</sup>	To evaluate the use of safety glasses with and without the presence and activities of trained peer-worker role models on harvesting crews	Trained Community Health Workers (CHWs), selected within the harvesters most respected by their peers. Comparison of safety eyewear adoption among 9 crews with a CHW to 4 control crews receiving safety glasses but having no CHW.	<ul style="list-style-type: none"> <li>• Baseline observation (repeatedly on 3 separate days over an 8-week period);</li> <li>• Observation during intervention (monitored from 4 to 15 weeks);</li> <li>• Face-to-face surveys</li> </ul>	Sample: Hispanics, primarily of Mexican origin (n = 278) Settings: USA (Southwest Florida)	SB	Intervention crews reported significantly higher rates of eyewear use than control crews. Intervention exposure time and level of worker use were strongly correlated.

Monaghan et al. (2012) <sup>48</sup>	To determine whether behavioral change increase the acceptance and use of safety glasses among citrus harvesters who have traditionally disdained use of protective eyewear	Community-based prevention marketing (CBPM) planning framework including CHW training sessions and observations by community members and university-based researchers	<ul style="list-style-type: none"> <li>•Participant-observer techniques;</li> <li>•Direct observations;</li> <li>•Individual and focus group interviews</li> </ul>	<p>Sample: Most Mexican migrant workers (observed n = 108, interviewed n = 74)</p> <p>Settings: USA (Southwest Florida)</p>	SB SAB HO	<p>Access to safety glasses equipped with worker-designed features reduced the perceived barriers of using them; deployment of trained peer-leaders helped promote adoption.</p> <p>Workers' use of safety glasses increased from less than 2% to between 28% and 37% in less than two full harvesting seasons. Less eye irritation from dust, sand, insects, and chemicals were reported</p>
Napolitano et al. (2002) <sup>49</sup>	To develop and evaluate a culturally appropriate and effective video aimed at teaching Latino farmworker families how to protect their children from pesticide exposure	Study divided into 4 steps: i) identifying the optimal training method and content; ii) evaluating existing educational materials on pesticides; iii) developing the selected method; iv) assessing the effectiveness of the video as an intervention	<ul style="list-style-type: none"> <li>•Step I: Focus groups (in Spanish). Questionnaire to determine their preference of method</li> <li>•Step II: Pre/post test questionnaire on the knowledge;</li> <li>•Step III: Development of the video;</li> <li>•Step IV: pre-post questionnaire with a subset of participants (n = 12) 7-items satisfaction questionnaire. 2 self-reported behavior questions Follow up 1 week later</li> </ul>	<p>Sample: parents from farmworker families born in Mexico (n = 59)</p> <p>Settings: USA (Oregon)</p>	SK SB	<p>Step I-II: parents had not consistently received pesticide education. Videos cited as the preferred method for pesticide education (52%).</p> <p>Step IV: pre and post-test performance did not differ for age, sex, previous training, language. Males and females of similar age and education had similar pre- test performance. Older participants scored lower than younger participants of similar education and gender.</p> <p>Follow up: no significant decreases in the test on self-reported knowledge 1 week later.</p> <p>Satisfaction: 69% of participants evaluate duration and information of the video good or excellent.</p> <p>Self-reported behavior: significant increase of correct behavior at home but not at work</p>
Quandt et al. (2001) <sup>50</sup>	To design a community-based and community driven intervention using different theoretical frameworks brought together (the Precede-	<ul style="list-style-type: none"> <li>• Recruitment and training of interested individuals from each worksite</li> <li>• Training (in Spanish) including discussion and demonstration videos and printed materials (flipchart and brochures)</li> <li>• Support of the field safety promoter with follow-up visits and educational materials.</li> </ul>	<ul style="list-style-type: none"> <li>• In-depth interviews conducted in Spanish, focus groups, notes and observation from community forums</li> <li>Follow-up visits to worksites during the summer</li> </ul>	<p>Sample: Total farmworkers (n = 84): African American (n = 12), Hispanic-white (n = 57), Non Hispanic-white (n = 1)</p> <p>Settings: USA (North Carolina)</p>	SB	<p>Training did actively encourage farmworkers to report infractions and become involved with the activities of the community-based organization.</p>



	Proceed planning framework)					
Quandt et al. (2013) <sup>51</sup>	To evaluate a lay health promoter program to improve pesticide-related knowledge and practices of Worker Protection Standard (WPS)	<ul style="list-style-type: none"> <li>• Community-based participatory research</li> <li>• Six lessons one-on-one in a minimum of five home visits (30-60 minutes)</li> <li>• Eighteen learning objectives defined</li> </ul>	Pre- and post- test questionnaires (68 items)	Sample: Latin or Hispanic (n = 658; n = 610 completed both pre/post test). 92.3% born in Mexico. Settings: USA (North Carolina)	SK SB	<p>Ways to reduce exposure to pesticide at home: pre-test knowledge ranged from 5.4% to 55.7%; post-test knowledge ranged from 53.7% to 97.1%.</p> <p>WPS recommendation: pre test knowledge ranged from 18,9% to 96,6%; post test knowledge ranged from 23,2% to 99,7%. The percentage of appropriate residential practices showed significant increases (<math>p=.0026</math> to <math>p &lt; .0001</math>)</p>
Suratman et al. (2016) <sup>28</sup>	To examine the effectiveness of an educational intervention to improve knowledge and perceptions for reducing OP (Organophosphorus pesticides) exposure among Indonesian and SA (South Australian) migrant farmworkers	<ul style="list-style-type: none"> <li>• A power point presentation used for Indonesian farmworkers, followed by a discussion;</li> <li>• A flipchart used to SA farmworkers with the same content followed by a discussion</li> </ul>	<ul style="list-style-type: none"> <li>• Pre-test (baseline);</li> <li>• Post-test after 3 months;</li> <li>• Questionnaire (in English and translated in Indonesian language)</li> </ul>	Sample: Indonesian migrant farmworkers (n = 30) and South Australian migrant farmworkers (n = 7) Settings: Indonesia Australia	SK SAB	<p>Improvement in scores of knowledge about adverse effects of OPs and knowledge about self-protection at follow up time (<math>P \leq 0.05</math>).</p> <p>Scores of perceived severity, perceived benefits, and cues to action did not statistically improve at follow-up time (<math>P &gt; 0.05</math>).</p> <p>From baseline to follow-up, scores increased by 3 points more in Indonesian farmworkers than SA migrant farmworkers.</p>
Tovar-Aguilar et al. (2014) <sup>52</sup>	To evaluate the Community-Based Prevention Marketing (CBPM) program, to improve citrus worker health	<ul style="list-style-type: none"> <li>• Select CHWs (community health workers) as trainers of their peer;</li> <li>• 20-hour training of CHWs Florida Prevention Research Center (FPRC) personnel conducting research;</li> <li>• Workers were divided in intervention crew and control crew (receive eyewear but had</li> </ul>	Focus group, face-to-face interviews, survey, participant observation	Sample: Citrus farmworkers (n = 300), 77% from Mexico, 3% from central America, and 20% N.A. Settings: USA (Florida)	SB	<ul style="list-style-type: none"> <li>• Workers recognized the importance of safety glasses but few workers wore them</li> <li>• Participation of CHW increases usage of PPE from 2% to 37%.</li> </ul> <p>Crews with CHWs had significantly higher rates of eyewear use than control crews (<math>t = -3.070</math>; <math>p = .012</math>).</p> <ul style="list-style-type: none"> <li>• Strong correlation between use of glasses and contact with CHW</li> </ul>

		no CHW)				
Vela Acosta et al. (2005) <sup>53</sup>	To evaluate a pesticide risk reduction program developed in a bilingual format	A 60 min. pesticide bilingual program training. Flipchart was used interactively, and farmworkers were asked to respond to real or simulated case scenarios (Spanish)	<ul style="list-style-type: none"> <li>• Pre-test (within 2 weeks);</li> <li>• Post-test 1 week after pesticide program;</li> <li>• Safety Risk Perception (SRP) 13 questions (Likert scale);</li> <li>• Health Locus of Control (HLC) 18 items each (Likert scale) ;</li> <li>• Transtheoretical model (TTM) 20 questions safety behaviors;</li> <li>• All translated from English to Spanish</li> </ul>	Sample: Hispanic farmworkers (n = 152) divided into experimental group (n =77) and control group (n = 75) Settings: USA (Colorado)	SK SB	The bilingual pesticide program effectively increased farmworkers' pesticide knowledge (p=0.0001), SRP (p=0.0001), and two (out of four) behavioral outcomes. Workers with external health locus of control were less likely to adopt safety behaviors (P=0.0001).

## HIGHLIGHTS.

- Training can contribute to reduce migrant farmworkers' risk exposure.
- A scoping review of the available literature on migrant farmworkers' training effectiveness was conducted.
- Improvements in safety knowledge were not always mirrored by an increased adoption of safety behaviors.
- Training programs based on a participatory community approach were the most effective.